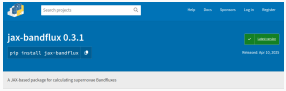
Bayesian Anomaly Detection:

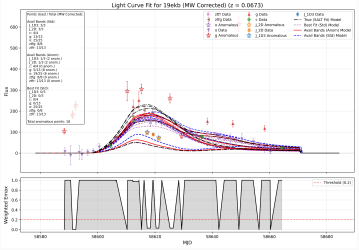
1. Define anomaly mask: $\varepsilon_i \in \{0, 1\}$
2. Bernoulli prior: $P(\varepsilon_i) = p^{\varepsilon_i}(1-p)^{(1-\varepsilon_i)}$
3. Piecewise likelihood:

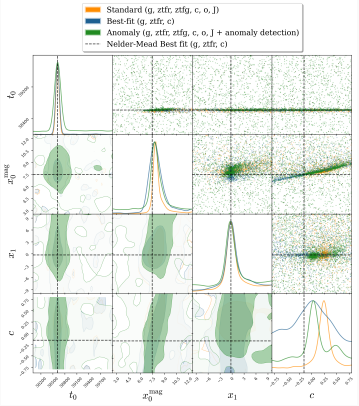
$$P(\vec{D}, \vec{\epsilon}|\theta) = \prod_{i=1}^{N} (L_i(\theta)(1-p))^{(1-\epsilon_i)} \left(\frac{p}{\Delta}\right)^{\epsilon_i}$$

4. Marginalize: $P(\mathcal{D}|\theta) = \sum_{\varepsilon} P(\mathcal{D}, \varepsilon|\theta)$
5. Dominant mask: $P(\mathcal{D}|\theta, \varepsilon_{\max}) \gg P(\mathcal{D}|\theta, \varepsilon^{(j)})$
6. Final loglikelihood:

$$\log P(\mathcal{D}|\theta) = \begin{cases} \log \mathcal{L}_i + \log(1-p), & \text{if expected} \\ \log p - \log \Delta, & \text{if anomalous} \end{cases}$$







Differentiable Bayesian Anomaly Detection for SALT3 Using JAX

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